CHAPTER - 11

GRANGER CAUSALITY BETWEEN RUPEE/NEPALESE RUPEE EXCHANGE
RATE AND RELATIVE PRICE LEVEL— STUDY WITH RESTRICTED VAR
MODEL

11.1 Introduction:

The **VAR** (2,4) Model estimated in Chapter 8 is *Unrestricted* by nature. In such
'*Unrestricted VAR*' model the specification of lag structures for both the variables, E_t and
P_t, is required to be uniform. This made the model '*Over Parameterized*'. Such an
Unrestricted VAR model' therefore, becomes less informative about *the nature* and
direction of causality between the variable concerned. In such case a *Restricted VAR
Model* may be more helpful for the purpose since it allows parsimony of lag structure for
both the endogenous variables in the system through the exclusion of insignificant lagged
variables from the vector of regressors for each endogenous variable. A variant of such
Restricted VAR model is usually adopted in the '*Granger Causality Test Procedure*'.
We, therefore, seek in this Chapter to examine the nature and direction of '*Granger
Causality*' between exchange rate and relative price level through the estimation of an
appropriate *Restricted VAR Model* for the variables concerned.

11.2 The Restricted VAR Model

The estimable *Restricted VAR Model* for E_t and P_t, following *Granger Causality Test
Procedure*, is being formulated and stated below. The *auto-regressive lag structure* for
each endogenous variable is confined to first lag only. However, the *distributed lag
structure* is retained unchanged in both the equations. Consequently, the model is

$$E_t = \alpha_1 + \beta_1 E_{t-1} + \gamma_1 P_{t-1} + \gamma_2 P_{t-2} + \gamma_3 P_{t-3} + \gamma_4 P_{t-4} + \omega_t \qquad (11.1)$$

$$P_t = \alpha_2 + \delta_1 P_{t-1} + \theta_1 E_{t-1} + \theta_2 E_{t-2} + \theta_3 E_{t-3} + \theta_4 E_{t-4} + \mu_t \qquad (11.2)$$

where $\quad \omega_t \sim iidN(0, \sigma_\omega^2)$

$$\mu_t \sim iidN(0, \sigma_\mu^2)$$

11.3 Estimation and Result

The *Restricted VAR Model* consisting of equations (11.1) and (11.2) are being estimated for the sub-period 1993:2-2006:1. Results of the estimation are being presented through the Tables 11.1 and 11.2 below.

Table 11.1

Results of the Estimation of the Restricted VAR Model (Equation 11.1)

Dependent Variable: E_t Sub-Period: 1993:2-2006:1   Sample(adjusted):

Included Observations: 46   (after adjusting endpoints)

Independent Variables	Coefficients	S.E	t-stat.	Prob.
Constant	-0.0004	0.001	-0.535	0.595
E_{t-1}	-0.460	0.142	-3.236	0.002
P_{t-1}	0.030	0.097	0.306	0.761
P_{t-2}	-0.056	0.093	-0.605	0.548
P_{t-3}	-0.001	0.093	-0.008	0.994
P_{t-4}	-0.169	0.091	-1.857	0.071
$R^2 = 0.274$ Adjusted $R^2 = 0.186$ AIC= -7.529 SIC= -7.293 DW= 2.277 F-Stat.= 3.097 Prob(F-statistic)= 0.018				

Table 11.2

Results of the Estimation of the Restricted VAR Model (Equation 11.2)

Dependent Variable: P_t Sub-Period: 1993:2-2006:1 Sample(adjusted):

Included Observations: 46   (after adjusting endpoints)

Independent Variables	Coefficients	S.E	t-stat.	Prob.
Constant	-0.0002	0.001	-0.114	0.909
P_{t-1}	0.085	0.161	0.528	0.600
E_{t-1}	-0.031	0.324	-0.096	0.924
E_{t-2}	0.224	0.376	0.597	0.554
E_{t-3}	0.361	0.370	0.975	0.335
E_{t-4}	0.349	0.313	1.114	0.272

$R^2 = 0.05$ Adjusted $R^2 = -0.071$
AIC = -6.294   SIC = -6.058
DW = 1.882   F-Stat.= 0.393
Prob(F-statistic) = 0.851

11.4   Findings From the Table 11.1

It is observed from the estimated equation (11.1) that

i. $\hat{\beta}_1$ is significant at 1% level.

ii. $|\hat{\beta}|$ = 0.460<1 and the system is *stable*.

iii. $\sum_{i=1}^{4} \gamma_i < 1$. So the distributive lag-structure is *consistent*.

iv.   DW= 2.277 indicates that the estimated equation is free from auto-correlation.

v. $\hat{\gamma}_4$ is significant at 1% level.

vi.   all other estimated coefficients $\hat{\alpha}_1, \hat{\gamma}_1, \hat{\gamma}_2$ *and* $\hat{\gamma}_3$ are not significant even at 10% level.

However, the equation (11.1) may be modified through the exclusion of the variables which appears to be statistically insignificant (even at 10% level). The modified equation is

$$E_t = \eta + \phi\, E_{t-1} + \pi\, P_{t-4} + \mu_{1t} \tag{11.3}$$

The estimable modified equation (11.3) is expected to provide better estimation in view of the gain in degrees of freedom resulting from the exclusion of insignificant variables (like p_{t-1}, p_{t-2} and p_{t-3}) from the vector of regressors for the endogenous variable E_t.

11.5   Results of Estimation of the Modified Equation (11.3) in the Restricted VAR System

Results of estimation of the modified equation (11.3) are being presented through the Table 11.3 below.

Table 11.3

Results of the Estimation of the Equation 11.3 in The Restricted VAR System

Dependent Variable: E_t Sub-Period: 1993:2-2006:1 Sample(adjusted):

Included Observations: 47   (after adjusting endpoints)

Independent Variables	Coefficients	S.E	t-stat.	Prob.
Constant	-0.0004	0.001	-0.582	0.562
E_{t-1}	-0.481	0.132	-3.634	0.001
P_{t-4}	-0.143	0.076	-1.879	0.067
$R^2 = 0.266$ Adjusted $R^2 = 0.232$ AIC= -7.645 SIC= -7.527 DW= 2.279 F-Stat.= 7.963 Prob(F-statistic)= 0.001				

11.6 Findings From the Estimated Modified Equation 11.3

It is observed from the estimated equation 11.3, shown in the Table 10.3, that

i. $\hat{\phi}$, the coefficient of E_{t-1} is significant at 1% level.

ii. $\hat{\phi}$ is negative and $|\hat{\phi}| < 1$.

iii. π, the coefficient of P_{t-4}, is significant at 10% level.

iv. DW = 2.279 indicates absence of autocorrelation in the estimated equation.

v. F-statistics = 7.963 registers an improvements over that in the estimated equation (11.1).

11.7 Economic Interpretations of Findings in Section 11.6

Economic implications of the findings are as follows:

i. *negative and significant $\hat{\phi}$, the coefficients of E_{t-1}, implies a declines in the current Rupee/Nepalese Rupee exchange rate following a rise in Rupee/Nepalese Rupee exchange rate in the previous period (quarter). This feature of the exchange rate testifies for existence of an inhibition to a possibility of run-away depreciation or appreciation of the exchange rate concerned over the period of study (1993:2-2006:1).*

ii. *significant π, the coefficient of P_{t-4} in the presence of lagged exchange rate E_{t-1} in the vector of regressors for E_t, indicates that variations in relative price level 'Granger Caused' those in exchange rate.*

iii. *$\pi<0$ indicates that exchange rate appreciates in response to a rise in four quarters back relative price level while cointegration study indicates a depreciation following a rise in the relative price level at the current period.*

The autocorrelations function, being 'even' by nature, indicates that exchange rate in it's the dynamic path of adjustment in response to a rise in current level of relative price level, exhibits a 'depreciation' first and then it shows a pattern of 'appreciation' with the passage of 4 quarters(one year)(thereafter). These testifies for the fact that the path

of dynamic adjustment of Rupee/Nepalese Rupee exchange rate exhibits the occurrence of 'Overshooting' phenomenon in response to a relative price level shock.

11.8 Findings From the Table 11.2 [Equation 11.2]

It is observed from the estimated equation 11.2 in the Table 11.2 that

i. $\hat{\delta}$, the estimated coefficient of P_{t-1}, is not significant even at 10% of significance.

ii. $\hat{\phi}_i (i = 1,2,3,4)$, the estimated coefficients of E_{t-i} (i=1,2,3,4) are not significant even at 10% level of significance.

iii. DW= 1.882 indicates that the equation is free from autocorrelation.

iv. F-Statistic = 0.393 with F-Probability = 0.852 indicate, that the joint estimation of the equation is not significant at even 10% level of significance.

11.9 Economic Implications of the Findings in Section 10.8

The findings in Section 11.8 show that

i. *variations in relative price level are not at all related to those in exchange rate. Therefore, relative exchange rate is not 'Granger Caused' by exchange rate.*

ii. *relative exchange rate, therefore, appears as an 'exogenous' variable in the **Restricted VAR System** consisting of equation (11.1) and (11.2).*

11.10 Overview of the Findings in Chapter 11

It is observed from the findings in our study with the estimated **Restricted VAR System** that, over the sub-period 1993:2-2006:1

i. *exchange rate was **Granger Caused** by relative price level.*

ii. *relative price level was not 'Granger Caused' by exchange rate.*

iii. *there exists 'Uni-directional Causality' running from relative price level to exchange rate.*

iv.   *relative price appears virtually as an exogenous variable in the **Restricted VAR System**. This confirms the findings of **exogeneity** of relative price level in the **Unrestricted VAR System** in Chapter 8.*

*We seek to enquire further into the nature and direction of causality between exchange rate and relative price level through 'Spectral Analysis' in next chapter. The '**Frequency Domain**' study is expected to supplant and supplement the '**Time Domain**' analysis.*